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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/711,892	10/12/2004	Anja C.S. Brau	GEMS8081.231	5891

27061 7590 05/15/2007

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EXAMINER	
TALMAN, JAMES R	

ART UNIT	PAPER NUMBER
3709	

MAIL DATE	DELIVERY MODE
05/15/2007	PAPER

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Office Action Summary	Application No.	Applicant(s)
	10/711,892	BRAU ET AL.
	Examiner	Art Unit
	James R. Talman	3709

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on 12 October 2004.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) 1-33 is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) 1-33 is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☒ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on 12 October 2004 is/are: a)☐ accepted or b)☒ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☒ Information Disclosure Statement(s) (PTO/SB/08) Paper No(s)/Mail Date 2/9/2006, 10/18/2004.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .
5) ☐ Notice of Informal Patent Application
6) ☐ Other: _____.

DETAILED ACTION

Specification

1. The disclosure is objected to because of the following informalities: On page 12, line 11, item 106 is not shown in any of the drawings.

Appropriate correction is required.

Drawings

2. The drawings are objected to because item 106 is mentioned in the specification but is not shown in any of the drawings. Corrected drawing sheets in compliance with 37 CFR 1.121(d) are required in reply to the Office action to avoid abandonment of the application. Any amended replacement drawing sheet should include all of the figures appearing on the immediate prior version of the sheet, even if only one figure is being amended. The figure or figure number of an amended drawing should not be labeled as "amended." If a drawing figure is to be canceled, the appropriate figure must be removed from the replacement sheet, and where necessary, the remaining figures must be renumbered and appropriate changes made to the brief description of the several views of the drawings for consistency. Additional replacement sheets may be necessary to show the renumbering of the remaining figures. Each drawing sheet submitted after the filing date of an application must be labeled in the top margin as either "Replacement Sheet" or "New Sheet" pursuant to 37 CFR 1.121(d). If the changes are not accepted by the examiner, the applicant will be notified and informed of any required

corrective action in the next Office action. The objection to the drawings will not be held in abeyance.

Claim Rejections - 35 USC § 102

1. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (e) the invention was described in (1) an application for patent, published under section 122(b), by another filed in the United States before the invention by the applicant for patent or (2) a patent granted on an application for patent by another filed in the United States before the invention by the applicant for patent, except that an international application filed under the treaty defined in section 351(a) shall have the effects for purposes of this subsection of an application filed in the United States only if the international application designated the United States and was published under Article 21(2) of such treaty in the English language.

2. Claims 1-9, and 12-26 are rejected under 35 U.S.C. 102(e) as being anticipated by Larson et al (US patent application publication 2004/0155653).

As per claim 1, Larson et al discloses an MRI apparatus as claimed, comprising determining motion in the region of interest (Synchronizing MR images to the motion of a patient, see abstract), using any k-space trajectory (for example radial, spiral, or Cartesian, paragraph 37) that pass through the origin of k-space (This is preferably done by acquiring data along k-space trajectories that frequently pass through the center (or origin) of k-space, paragraph 36), and using non-imaging, non-spatially-encoded data (The timing information does not need to be extracted exclusively from imaging data, ... Paragraph 60). Further, Larson et al implies the possibility of acquiring data at least once every repetition interval of a pulse sequence if necessary (It is not necessary that every data acquisition trajectory pass through the k-space origin,

but it is preferred that this happen relatively frequently....., paragraph 38). Further, Larson et al implies a plurality of gradient coils, an RF transceiver system, an RF switch, and an RF coil assembly, and a computer to process the data (processed timing data, paragraph 18), because these components are all necessary to generate an MR image.

As per claim 2, Larson et al further discloses using magnitude or phase information to determine motion (e.g. magnitude, phase, rate of change – may be useful for synchronizing the associated imaging data, paragraph 45).

As per claims 3 and 4, Larson et al further discloses using the motion information for retrospective or prospective gating (synchronize, paragraph 18), and respiratory-gated acquisition (Respiratory motion information can be extracted directly from the MR data and used to synchronize the image data with the quiescent period of the respiratory cycle, avoiding motion artifacts, paragraph 14).

As per claim 5, Larson et al further discloses using the motion information to adjust scan timing, e.g. slice timing, (provide temporal correspondence with the motion, paragraph 18).

As per claim 6, Larson et al further discloses retrospective correction of phase errors (synchronization of the data can be done retrospectively, paragraph 50).

As per claim 7, Larson et al further discloses using a plurality of k-space points (k-space points at or near the origin, paragraph 17).

As per claim 8, Larson et al discloses determining fluctuations (various characteristics of the signal – e.g. rate of change, paragraph 45). The signal is

inherently dependent on transverse magnetization, as all MR signals are determined by the transverse component of the spin magnetization.

As per claim 9, Larson et al further discloses an assembly with a plurality of RF coils (a surface array, paragraph 53), and combination of the information from the multiple coils (combination of the information, paragraph 54).

As per claim 12, MRI apparatus having a bore must inherently have a table to move the patient fore and aft within the bore because the space, typically 1m diameter, is too cramped for a patient to physically maneuver himself or herself in and out of the bore. MR systems not having a bore, for example open MR systems, would not require a patient table.

As per claim 13, Larson et al further discloses accepting/rejecting data based on the determined motion (selection done automatically based on the amplitude of the signal variation due to motion, paragraph 54).

As per claim 14, Larson et al discloses acquiring MR data during non-breathold intervals (free breathing, paragraph 14).

As per claim 15, Larson et al discloses a method of MR imaging comprising sampling MR data over a plurality of repetition time intervals for a central region of k-space (It is not necessary that every data acquisition trajectory pass through the k-space origin, but it is preferred that this happen relatively frequently….., paragraph 38), and determining motion in the region of interest (Synchronizing MR images to the motion of a patient, see abstract), using any k-space trajectory (for example radial, spiral, or Cartesian, paragraph 37) that passes through the origin of k-space (This is

preferably done by acquiring data along k-space trajectories that frequently pass through the center (or origin) of k-space, paragraph 36).

As per claim 16, Larson et al further discloses acquiring MR data from a plurality of RF coils (a surface array, paragraph 53), and combining the signals from the multiple coils (combination of the information, paragraph 54).

As per claim 17, Larson et al further discloses determing which RF coil is most sensitive to motion (Thus, it may be advantageous to select only one of the imaging coils (with the selection done automatically based on the amplitude of the signal variation due to motion), paragraph 54).

As per claim 18, Larson et al further discloses using magnitude or phase information to determine motion (e.g. magnitude, phase, rate of change – may be useful for synchronizing the associated imaging data, paragraph 45).

As per claim 19, Larson et al further discloses multi-shot acquisition, i.e. one having multiple k-space trajectories (every data acquisition trajectory pass through the k-space origin, but it is preferred that this happen relatively frequently….., paragraph 38).

As per claims 20 and 21, Larson et al further discloses using the motion information for retrospective or prospective gating (synchronize, paragraph 18), and respiratory-gated acquisition (Respiratory motion information can be extracted directly from the MR data and used to synchronize the image data with the quiescent period of the respiratory cycle, avoiding motion artifacts, paragraph 14). Larson et al further discloses retrospective-gating to correct for cardiac-induced motion (Figure 6).

As per claim 22, Larson et al further discloses retrospective correction of phase errors (synchronization of the data can be done retrospectively, paragraph 50).

As per claim 23, Larson et al discloses sampling of MR data for the central region of k-space (origin) and, further implies the possibility of acquiring data at least once every repetition interval of a pulse sequence if necessary (It is not necessary that every data acquisition trajectory pass through the k-space origin, but it is preferred that this happen relatively frequently....., paragraph 38).

As per claim 24, Larson et al discloses acquiring MR data during non-breathold intervals (free breathing, paragraph 14).

As per claims 25 and 26, Larson et al discloses determining motion in the region of interest (Synchronizing MR images to the motion of a patient, see abstract), using any k-space trajectory (for example radial, spiral, or Cartesian, paragraph 37) that passes through the origin of k-space (This is preferably done by acquiring data along k-space trajectories that frequently pass through the center (or origin) of k-space, paragraph 36). Thus, the method of Larson et al does not require a separate acquisition of physiological motion data, and is independent of motion type.

Claim Rejections - 35 USC § 103

3. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

4. Claim 27 is rejected under 35 U.S.C. 103(a) as being unpatentable over Larson et al (US patent application publication 2004/0155653).

As per claim 27, Larson et al discloses using a plurality of k-space points centered about the origin (k-space points at or near the origin, paragraph 17). Larson et al as applied to claim 15 above discloses all the remaining elements of the claimed invention except that it does not explicitly disclose sampling the origin of k-space twice during each repetition interval.

Larson et al implies the possibility of acquiring data multiple times during each repetition interval of a pulse sequence if necessary (It is not necessary that every data acquisition trajectory pass through the k-space origin, but it is preferred that this happen relatively frequently….., paragraph 38). It would have been obvious to a person having ordinary skill in the art at the time of the invention to modify Larson et al to acquire k-space origin data multiple times during each repetition interval if necessary to compensate for motion that was changing significantly during a single repetition interval.

5. Claims 10, 11, and 33 are rejected under 35 U.S.C. 103(a) as being unpatentable over Larson et al (US patent application publication 2004/0155653) in view of Haacke et al (Haacke et al, Magnetic Resonance Imaging, John Wiley and Sons, 1999).

As per claims 10 and 11, Larson et al discloses retrospective correction of imaging data (synchronization of the data can be done retrospectively, paragraph 50). Further, Larson et al as applied to claim 2 above disclose all the remaining elements of the claimed invention except that it does not explicitly disclose sampling the origin of k-

space twice during each repetition interval and it does not disclose the use of rewinder gradient pulses.

Larson et al implies the possibility of acquiring data multiple times during each repetition interval of a pulse sequence if necessary (It is not necessary that every data acquisition trajectory pass through the k-space origin, but it is preferred that this happen relatively frequently....., paragraph 38). It would have been obvious to a person having ordinary skill in the art at the time of the invention to modify Larson et al to acquire k-space origin data multiple times during each repetition interval if necessary to compensate for rapid motion that was changing significantly during a single repetition interval.

Haacke et al disclose the use of rewinder gradient pulses (rewound gradients, p. 796). It would have been obvious to a person having ordinary skill in the art at the time of the invention to modify Larson et al to use rewinder gradients as taught by Haacke et al in order to accomplish first-order motion compensation.

As per claim 33, Larson et al discloses a method of MR imaging comprising determining motion in the region of interest (Synchronizing MR images to the motion of a patient, see abstract), using any k-space trajectory (for example radial, spiral, or Cartesian, paragraph 37) that pass through the origin of k-space a plurality of times (This is preferably done by acquiring data along k-space trajectories that frequently pass through the center (or origin) of k-space, paragraph 36). Furthermore, k-space origin data for any given slice, by definition, are acquired with spatial encoding gradients set to zero, i.e. non-spatially encoded. Larson et al does not disclose the use of

rewinder gradient pulses. Haacke et al disclose the use of rewinder gradient pulses (rewound gradients, p. 796) every repetition interval. Larson et al and Haacke et al are analogous art because both are solving the problem of motion compensation in MR imaging. It would have been obvious to a person having ordinary skill in the art at the time of the invention to modify Larson et al to use rewinder gradients as taught by Haacke et al in order to accomplish first-order motion compensation. Furthermore, Larson et al acquires k-space origin data in multiple repetition intervals, in which case rewinder gradients would be applied between acquisitions.

6. Claims 28-32 are rejected under 35 U.S.C. 103(a) as being unpatentable over Larson et al (US patent application publication 2004/0155653), in view of Ho et al (US patent application publication 2003/0216637).

As per claim 28, Larson et al discloses acquiring MR data to determine motion in a region of interest (Synchronizing MR images to the motion of a patient, see abstract), based on magnitude or phase differences (e.g. magnitude, phase, rate of change – may be useful for synchronizing the associated imaging data, paragraph 45), using any k-space trajectory (for example radial, spiral, or Cartesian, paragraph 37) that passes through the origin of k-space (This is preferably done by acquiring data along k-space trajectories that frequently pass through the center (or origin) of k-space, paragraph 36). Further, Larson et al implies the possibility of acquiring data at least once every repetition interval of a pulse sequence if necessary (It is not necessary that every data acquisition trajectory pass through the k-space origin, but it is preferred that this happen relatively frequently....., paragraph 38). Further, although Larson et al discloses

processing of data (processed timing data, paragraph 18), it does not explicitly disclose a computer readable storage medium. Ho et al discloses a computer readable storage medium for an MR scanner (paragraph 14). It would have been obvious to a person having ordinary skill in the art at the time of the invention to include a computer readable storage medium as taught by Ho et al because storage of the resulting images on a computer readable storage medium is necessary to display images at a later date and is routinely used in the MR art.

As per claim 29, data acquired at the center of k-space, by definition, is acquired with spatial encoding gradients set to zero. Furthermore, k-space origin data is acquired once each repetition time interval, which determines the resolution of motion sampling. The exact instant during the repetition time interval when k-space origin data is acquired (whether before or after further spatial encoding gradients are applied) is an obvious design choice. It would have been obvious to one of ordinary skill at the time of the invention to vary the precise instant when k-space data are acquired because it has been held that rearranging parts of an invention involves only routine skill in the art. *In re Japikse*, 86 USPQ 70.

As per claim 30, the method of Larson et al, as applied to claim 28 above, is independent of the cause of motion and therefore inherently determines motion caused by respiratory and cardiac movement simultaneously. Larson does not explicitly disclose delineating between the two causes of motion. However, the two motions occur on significantly different time scales and are therefore easily separated using filtering methods that are well known in the art.

As per claim 31, Larson et al further discloses retrospective correction of phase errors (synchronization of the data can be done retrospectively, paragraph 50).

As per claim 32, Larson et al further discloses using the motion information for retrospective or prospective gating (synchronize, paragraph 18), and respiratory-gated acquisition (Respiratory motion information can be extracted directly from the MR data and used to synchronize the image data with the quiescent period of the respiratory cycle, avoiding motion artifacts, paragraph 14).

Conclusion

7. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure.

"Motion Correction With PROPELLER MRI: Application to Head Motion and Free-Breathing Cardiac Imaging," Pipe, James G., Magnetic Resonance in Medicine 42:963-969 (1999). Early disclosure of motion compensation by sampling central region of k-space.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to James R. Talman whose telephone number is 571-270-3029. The examiner can normally be reached on 7:30-5:00.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Lynda Jasmin can be reached on 571-270-3033. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

James R Talman
Examiner
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Jrt

Benny Tieu

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PRIMARY EXAMINER